

Gamma Library Creation with Nucleonica

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NuTRONS 1: Nucleonica Training on Nuclear Science

Joint EC/IAEA Nuclear Science Training Course

with Nucleonica , 12th -15th October 2010

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Postfach 2340, 76125 Karlsruhe, Germany*

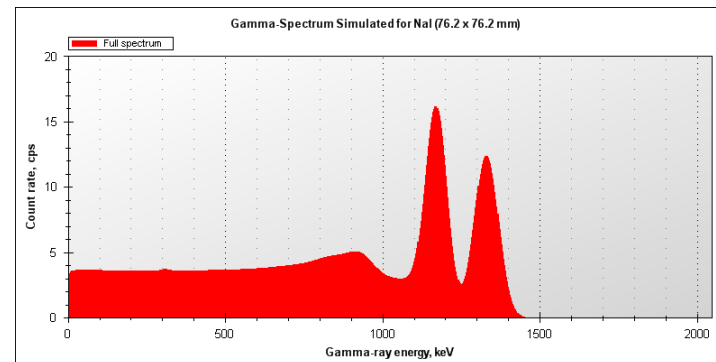
*<http://www.nucleonica.net/>
<http://itu.jrc.ec.europa.eu/>*



Why do we need gamma libraries?

How does the gamma library module work?

How do we create a 'useful' library?




nucleonica ... web driven nuclear science

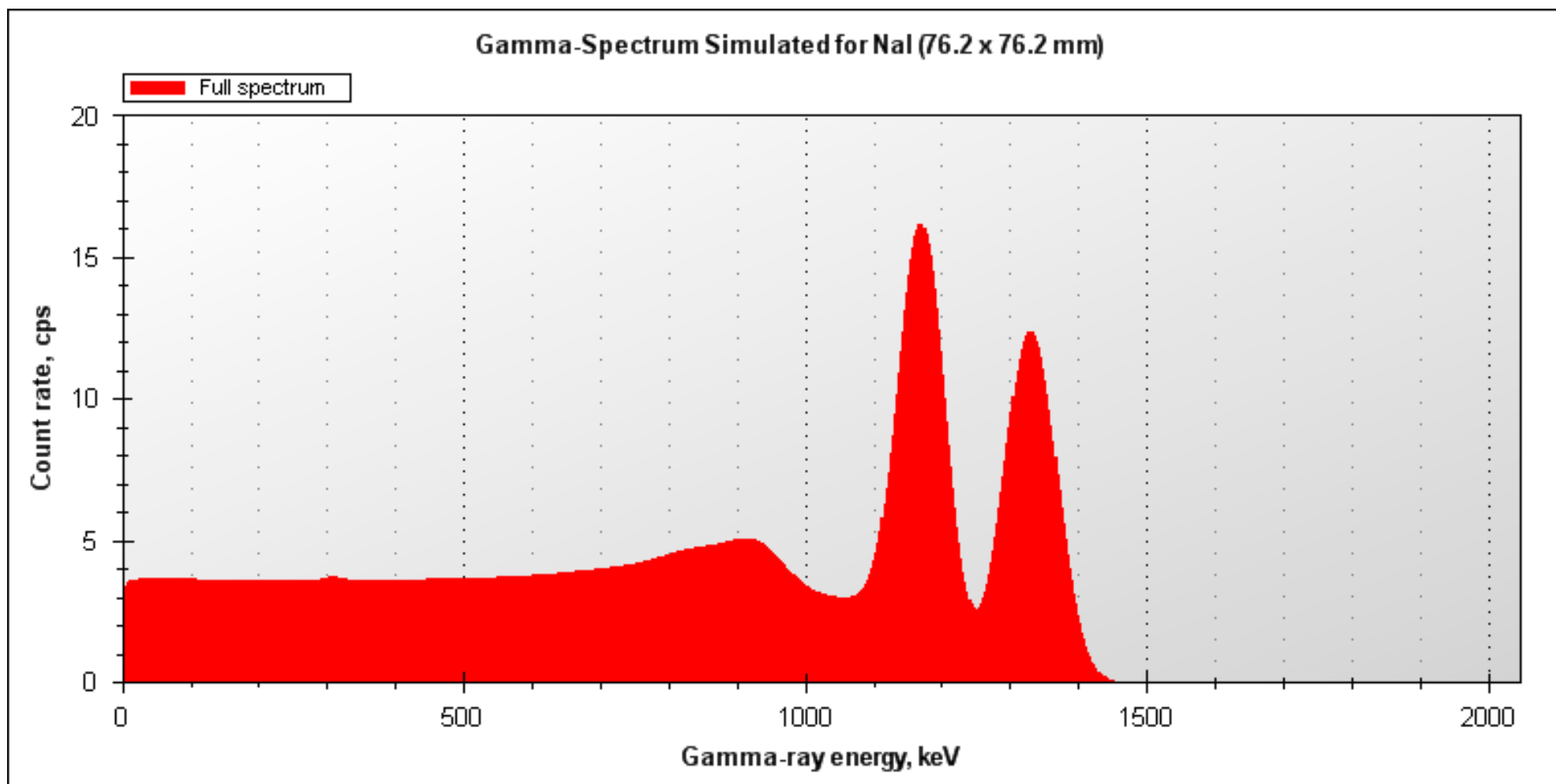
Applications Data Knowledge My Preferences Print Help New Browser

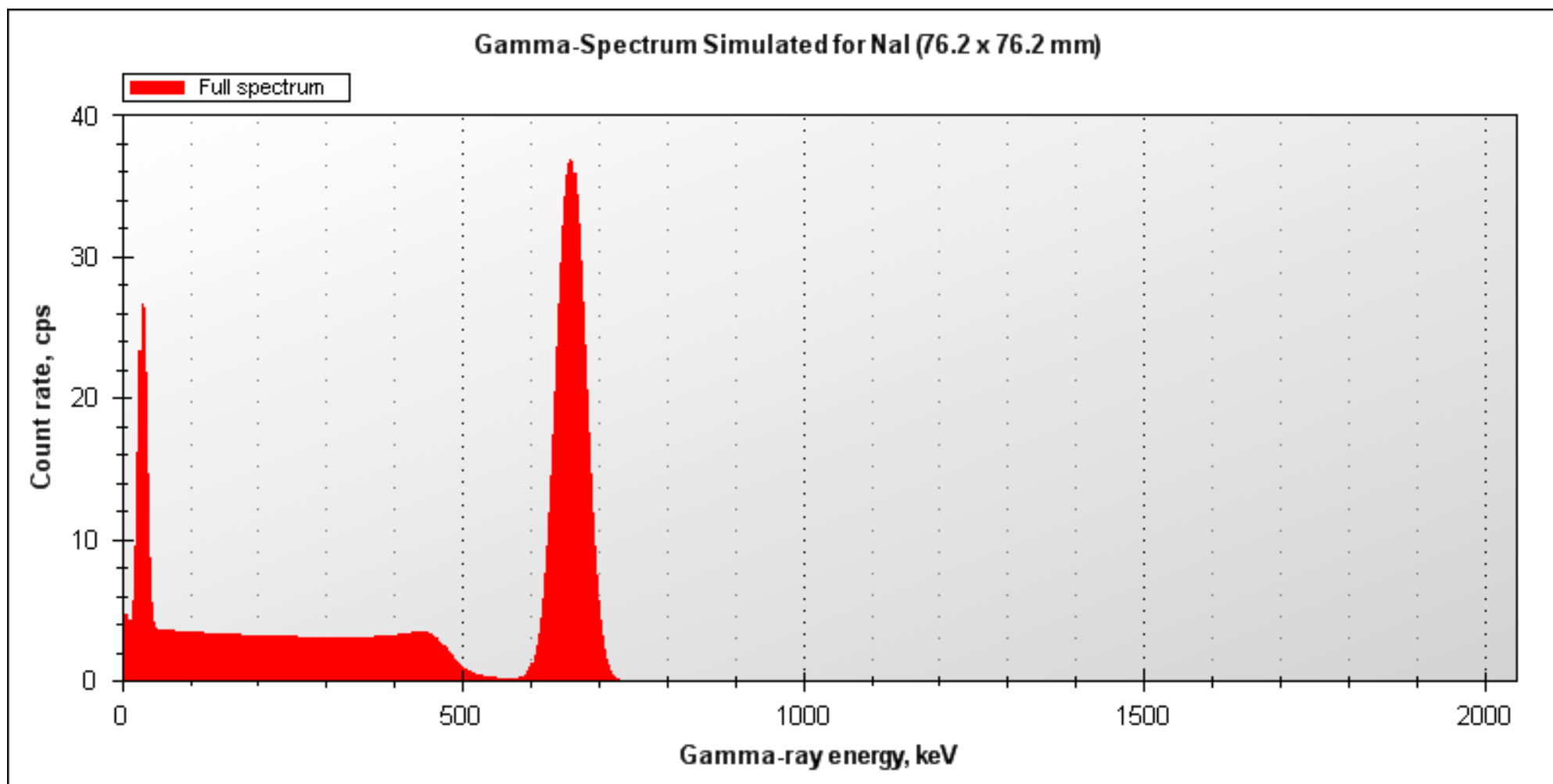
 **Gamma Library**

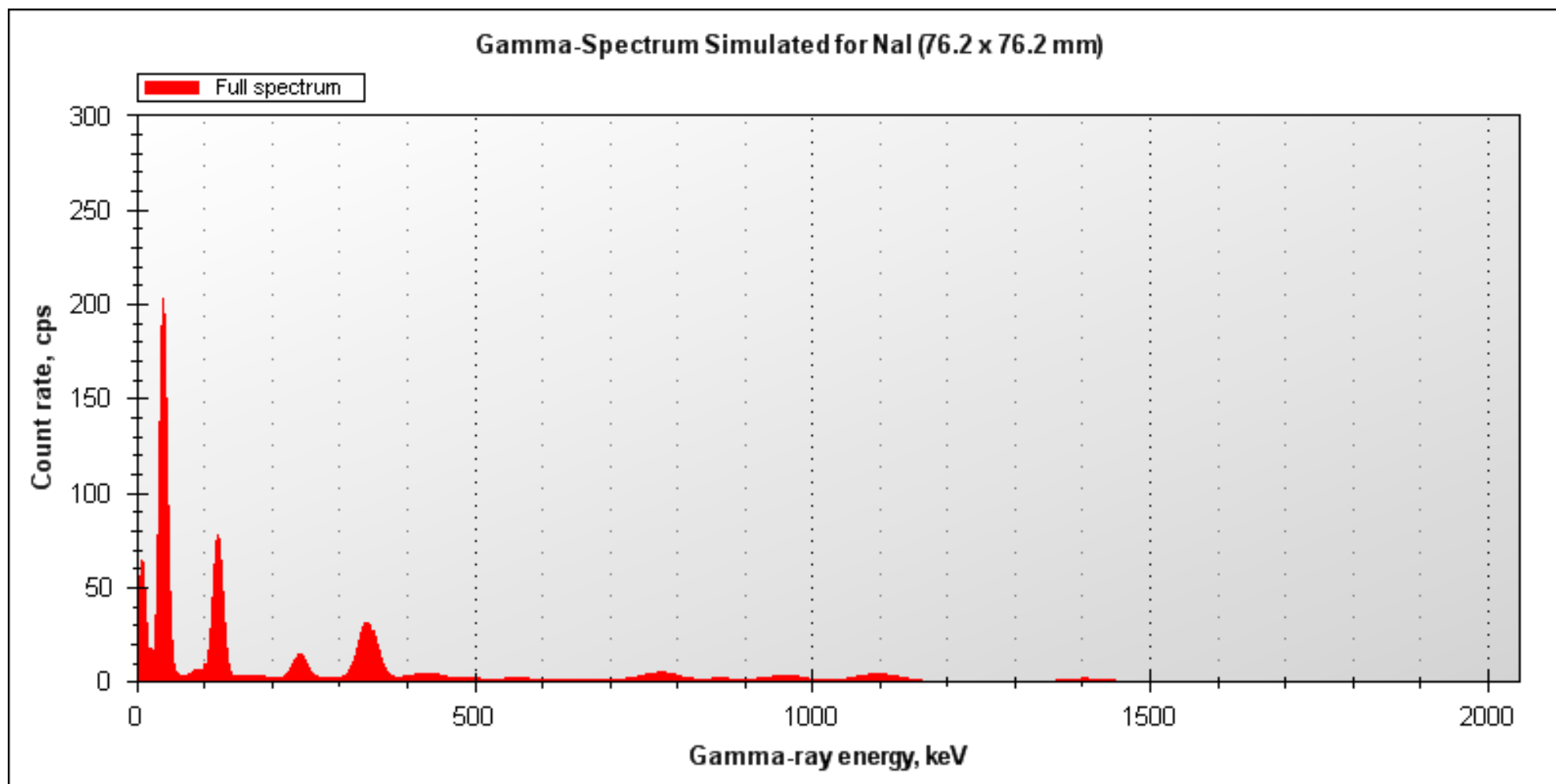
Summary Create/Edit Sample Libraries Options

User defined gamma libraries

ID	Name	Date Modified	Download	Delete
	(Create a new Library)			
8	Calibration Sources	19.08.2010, 13:13:31		
9	Medical Library	08.07.2010, 16:15:27		
Total: 2		Page: 1 / 1		







basic principle of gamma spectrometry:

energy of the emitted gamma photon is characteristic for the emitting isotope!

(like the human fingerprint in Rolf's presentation)



We can identify isotopes

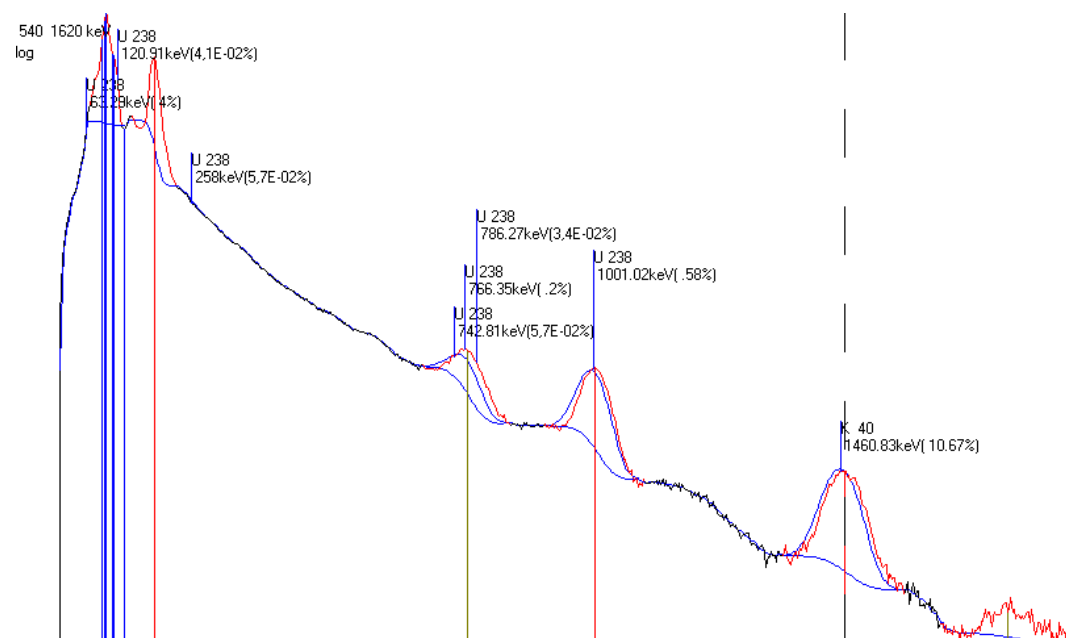
in a spectrum by using

a reference catalogue or library!

Gamma energy [keV] and

emission probability

[% rel. to all peaks of one nuclide]



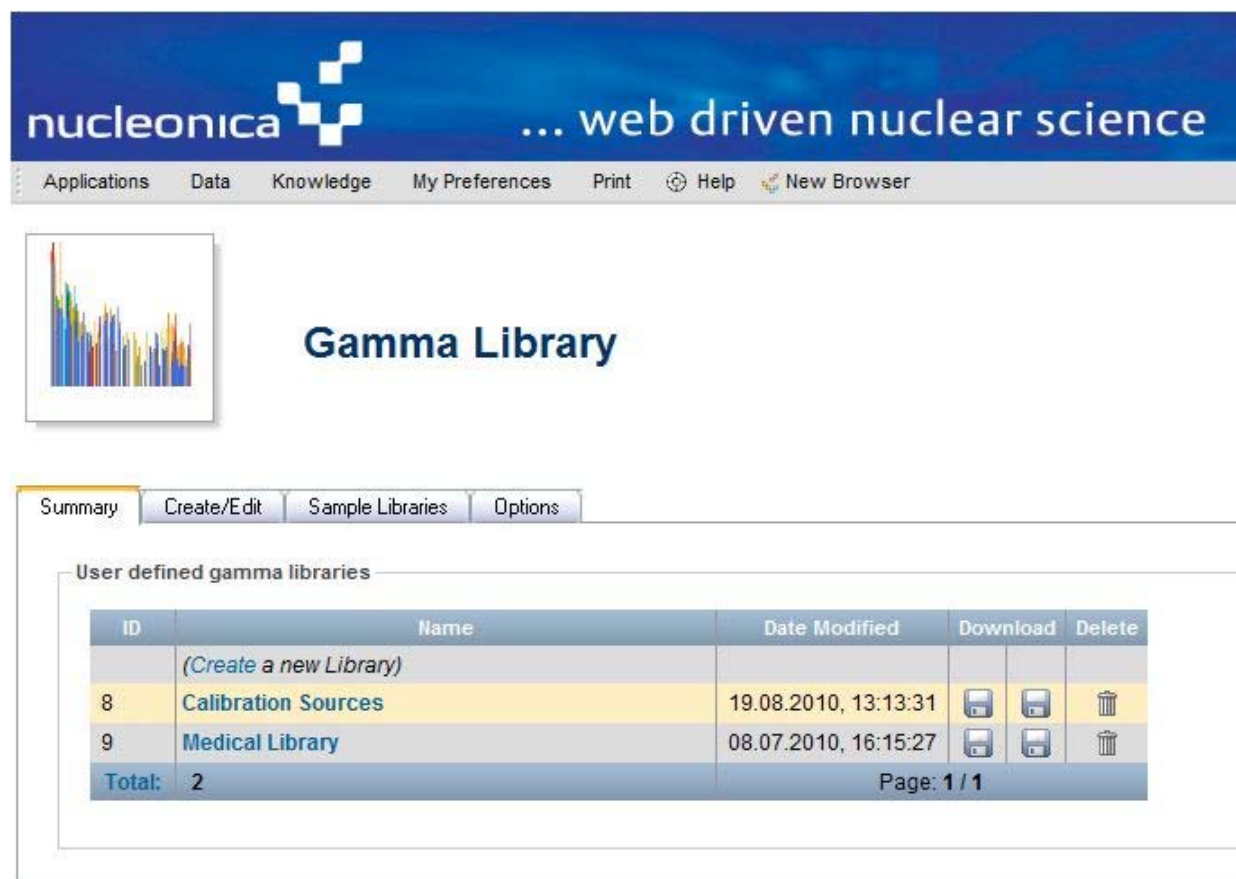
Spectrum identification programs (like GammaVision, Identify, etc.) rely on user-created library files.

The Gamma Library module
simplifies the library creation
for 3rd party software!

Create/ Edit your libraries

Save as .lib file for GammaVision
(binary file) or Identify (txt-file)

Sample libs available



The screenshot shows the 'nucleonica' web interface with the tagline '... web driven nuclear science'. The navigation bar includes 'Applications', 'Data', 'Knowledge', 'My Preferences', 'Print', 'Help', and 'New Browser'. The main content area is titled 'Gamma Library' and features a small spectrum plot icon. Below this, there are tabs for 'Summary', 'Create/Edit', 'Sample Libraries', and 'Options'. The 'Summary' tab is active, displaying a table of 'User defined gamma libraries'.

ID	Name	Date Modified	Download	Delete
	(Create a new Library)			
8	Calibration Sources	19.08.2010, 13:13:31		
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Total:	2			

Page: 1 / 1

Getting started:


nucleonica

Applications Data Knowledge

- Nuclide Explorer
- Mass Activity Calculator
- Decay Engine
- Dosimetry and Shielding
- Range and Stopping Power
- webKORIGEN
- Universal Nuclide Chart
- Transport and Packaging
- Nuclide Mixtures
- Nucleonica Scripting
- Library Creation
- Gamma Spectrum Generator
- easy Monte Carlo
- Cambio file converter
- WESPA
- Gamma Library**
- webGraph





nucleonica ... web driven nuclear science

Applications Data Knowledge My Preferences Print Help New Browser

 **Gamma Library**

Summary Create/Edit Sample Libraries Options

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	(Create a new Library)			
8	Calibration Sources	19.08.2010, 13:13:31		
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Total:	2			

Page: 1 / 1

Summary

Create/Edit

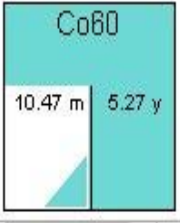
Sample Libraries

Options

Name:

Description:

Current Chart: Karlsruhe



Co

60

☒ Consider daughters

Peak Selection

☐ All Peaks
☐ High resolution (HPGe)
☒ Low resolution (NaI)
☐ Deselect all

Emission type

☒ Gamma lines
☒ X-Rays

Add Nuclide

Save

Library Nuclides

Nuclide	Half-life	Delete
0 Nuclide	Page: 0 / 0	

Radiations from selected Nuclide

Energy	Emission Probability	Type
0 / 0 Peak		Page: 0 / 0

⇒

⇐

Radiation Library

Nuclide	Energy (keV)	Emission Probability	Type
Total:	0 Peak		Page: 0 / 0

Daughters from selected Nuclide

Nuclide	Half-life
0 Daughter	Page: 0 / 0

NuTroNS 1, Monaco, 12th - 15th October 2010

Summary

Create/Edit

Sample Libraries

Options

Name:

NuTroNS_Test1

Description:

A test library for the NuTroNS course.

Current Chart: Karlsruhe

Co

60

☒ Consider daughters

Peak Selection

☐ All Peaks
☐ High resolution (HPGe)
☐ Low resolution (NaI)
☐ Deselect all

Emission type

☒ Gamma lines
☒ X-Rays

Add Nuclide

Library Nuclides

Nuclide	Halflife	Delete
27 Co 60	5.2713 y	
1 Nuclide	Page: 1 / 1	

Daughters from 27 Co 60

Nuclide	Halflife
0 Daughter	Page: 0 / 0

Radiations from 27 Co 60

Energy	Emission Probability	Type
1.332e+3	0.9998	Gamma
1.173e+3	0.9985	Gamma
826.1	7.600e-5	Gamma
347.14	7.500e-5	Gamma
7.478	6.438e-5	X-Ray
7.461	3.270e-5	X-Ray
8.26	1.311e-5	X-Ray
2.159e+3	1.200e-5	Gamma
0.85	1.495e-6	X-Ray
2.506e+3	2e-8	Gamma
2 / 10 Peaks	Page: 1 / 1	

Save

Radiation Library

Nuclide	Energy (keV)	Emission Probability	Type
27 Co 60	1.332e+3	0.9998	Gamma
27 Co 60	1.173e+3	0.9985	Gamma
Total:	2 Peaks		Page: 1 / 1

NuTroNS 1, Monaco, 12th - 15th October 2010

Library Nuclides

Nuclide	Halflife	Delete
27 Co 60	5.2713 y	
55 Cs 137	30.1671 y	
56 Ba 137m	2.55 m	
92 U 238	4.468 Gy	
4 Nuclides		Page: 1 / 1

Radiations from 92 U 238

Energy	Emission Probability	Type
13.409	0.07332	X-Ray
4.176	0.01438	X-Ray
49.55	6.800e-4	Gamma
113.5	1.700e-4	Gamma
1 / 4 Peak		Page: 1 / 1

Current Chart: Karlsruhe



U 238
☒ Consider daughters

Include daughters

Add Nuclide

Daughters from 92 U 238

Nuclide ▾	Halflife
92 U 234	245.5 ky
91 Pa 234m	1.17 m
90 Th 234	24.10 d
90 Th 230	75.38 ky
88 Ra 226	1.600 ky
86 Rn 222	3.8235 d
84 Po 218	3.10 m
84 Po 214	164.3 us
84 Po 210	138.376 d
83 Bi 214	19.9 m
83 Bi 210	5.012 d
82 Pb 214	26.8 m
82 Pb 210	22.20 y
13 Daughters	Page: 1 / 1

Radiations from 91 Pa 234m

Energy	Emission Probability	Type
1.001e+3	8.350e-3	Gamma
14.091	8.336e-3	X-Ray
98.439	3.434e-3	X-Ray
766.4	3.190e-3	Gamma
94.665	2.126e-3	X-Ray
4.463	1.607e-3	X-Ray
742.8	9.352e-4	Gamma
111.3	7.555e-4	X-Ray
258.2	7.348e-4	Gamma
13.746	5.050e-4	X-Ray
786.3	4.843e-4	Gamma
114.5	4.224e-4	X-Ray
110.4	3.983e-4	X-Ray
1737.8	2.121e-4	Gamma
4.319	1.762e-4	X-Ray
1831.7	1.728e-4	Gamma
1.194e+3	1.311e-4	Gamma
1510.1	1.303e-4	Gamma
73.92	1.253e-4	Gamma
922	1.236e-4	Gamma
2 / 135 Peaks		Page: 1 / 7

Save

Radiation Library

Nuclide	Energy (keV)	Emission Probability	Type
91 Pa 234m	1.001e+3	8.350e-3	Gamma
91 Pa 234m	766.4	3.190e-3	Gamma
56 Ba 137m	661.7	0.9007	Gamma
56 Ba 137m	32.19	0.03815	X-Ray
56 Ba 137m	31.82	0.02068	X-Ray
27 Co 60	1.173e+3	0.9985	Gamma
27 Co 60	1.332e+3	0.9998	Gamma
Total: 7 Peaks		Page: 1 / 1	


NuTroNS 1, Monaco, 12th - 15th October 2010

Summary
Create/Edit
Sample Libraries
Options

Name:

Description:

Current Chart: Karlsruhe



Cs 137

☒ Consider daughters

Peak Selection

☐ All Peaks

☐ High resolution (HPGe)

☒ Low resolution (NaI)

☐ Deselect all

Emission type

☒ Gamma lines

☒ X-Rays

Library Nuclides

Nuclide	Halflife	Delete
27 Co 60	5.2713 y	
55 Cs 137	30.1671 y	
2 Nuclides		Page: 1 / 1

Radiations from 55 Cs 137

Energy	Emission Probability	Type
283.5	5.800e-6	Gamma
1 / 1 Peak		Page: 1 / 1

Daughters from 55 Cs 137

Nuclide	Halflife
56 Ba 137m	2.55 m
1 Daughter	

Radiation Library

Nuclide	Energy (keV)	Emission Probability	Type
27 Co 60	1.173e+3	0.9985	Gamma
27 Co 60	1.332e+3	0.9998	Gamma
Total:	2 Peaks		Page: 1 / 1

Radiations from ⁵⁶Ba 137m

Energy	Emission Probability ▼	Type
661.7	0.9007	Gamma
32.19	0.03815	X-Ray
31.82	0.02068	X-Ray
36.4	0.01388	X-Ray
4.47	0.01042	X-Ray
1 / 5 Peak		Page: 1 / 1

Peak Selection

☐ All Peaks

☒ High resolution (HPGe)

☐ Low resolution (NaI)

☐ Deselect all

Emission type

☒ Gamma lines

☒ X-Rays

Select peaks automatically based on resolution

Radiations from 56 Ba 137m

Energy	Emission Probability ▼	Type
661.7	0.9007	Gamma
32.19	0.03815	X-Ray
31.82	0.02068	X-Ray
36.4	0.01388	X-Ray
4.47	0.01042	X-Ray
1 / 5 Peak		Page: 1 / 1

you will need:

for high resolution – more lines

for low resolution – less lines

Peak Selection
☐ All Peaks
☒ High resolution (HPGe)
☐ Low resolution (NaI)
☐ Deselect all

Emission type
☒ Gamma lines
☒ X-Rays

Peak Selection
☐ All Peaks
☐ High resolution (HPGe)
☒ Low resolution (NaI)
☐ Deselect all

Emission type
☒ Gamma lines
☒ X-Rays

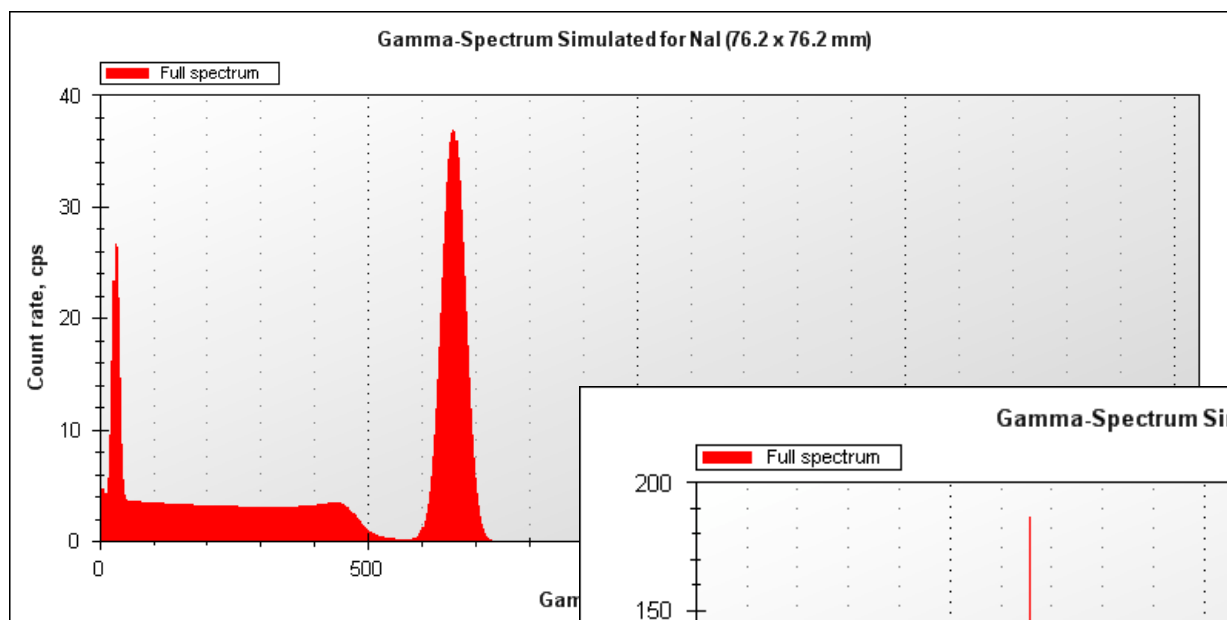
Select peaks based on resolution

Radiations from 56 Ba 137m

Energy	Emission Probability ▼	Type
661.7	0.9007	Gamma
32.19	0.03815	X-Ray
31.82	0.02068	X-Ray
36.4	0.01388	X-Ray
4.47	0.01042	X-Ray
1 / 5 Peak		Page: 1 / 1

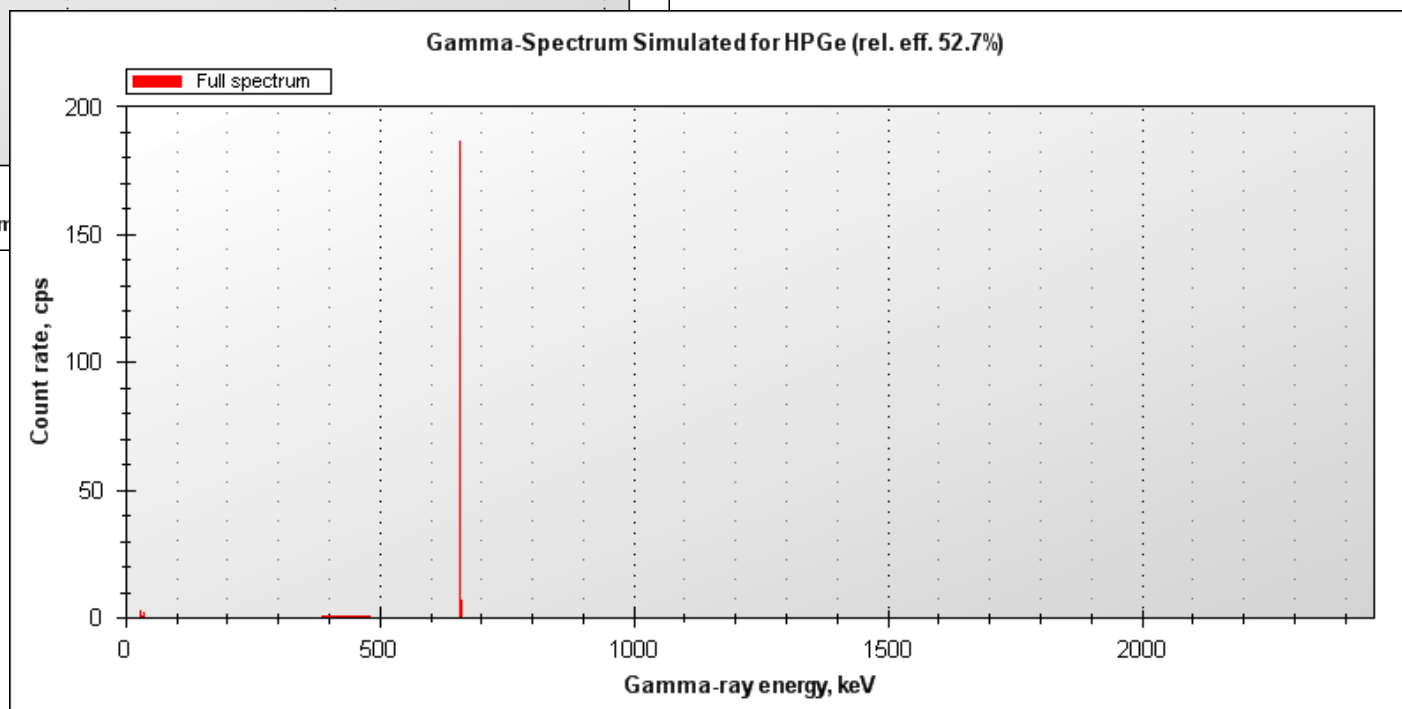
Radiations from 56 Ba 137m

Energy	Emission Probability ▼	Type
661.7	0.9007	Gamma
32.19	0.03815	X-Ray
31.82	0.02068	X-Ray
36.4	0.01388	X-Ray
4.47	0.01042	X-Ray
3 / 5 Peaks		Page: 1 / 1



Ba-137m

In the HPGe detector
a 'reflector' filters out
the low energy lines!



Summary Create/Edit Sample Libraries **Options**

Database:

Min. Branching ration for daughters:

Peak selection: high resolution detectors

Min. Energy

keV

Max. Energy

keV

Min. Emission probability

% of E.P. of strongest line

Min. Emission probability

% of E.P. of strongest higher energetic line

Peak selection: low resolution detectors

Min. Energy

keV

Max. Energy

keV

Min. Emission probability

% of E.P. of strongest line

Min. Emission probability

% of E.P. of strongest higher energetic line

Set an energy threshold for
your Germanium detector
because of a reflector!

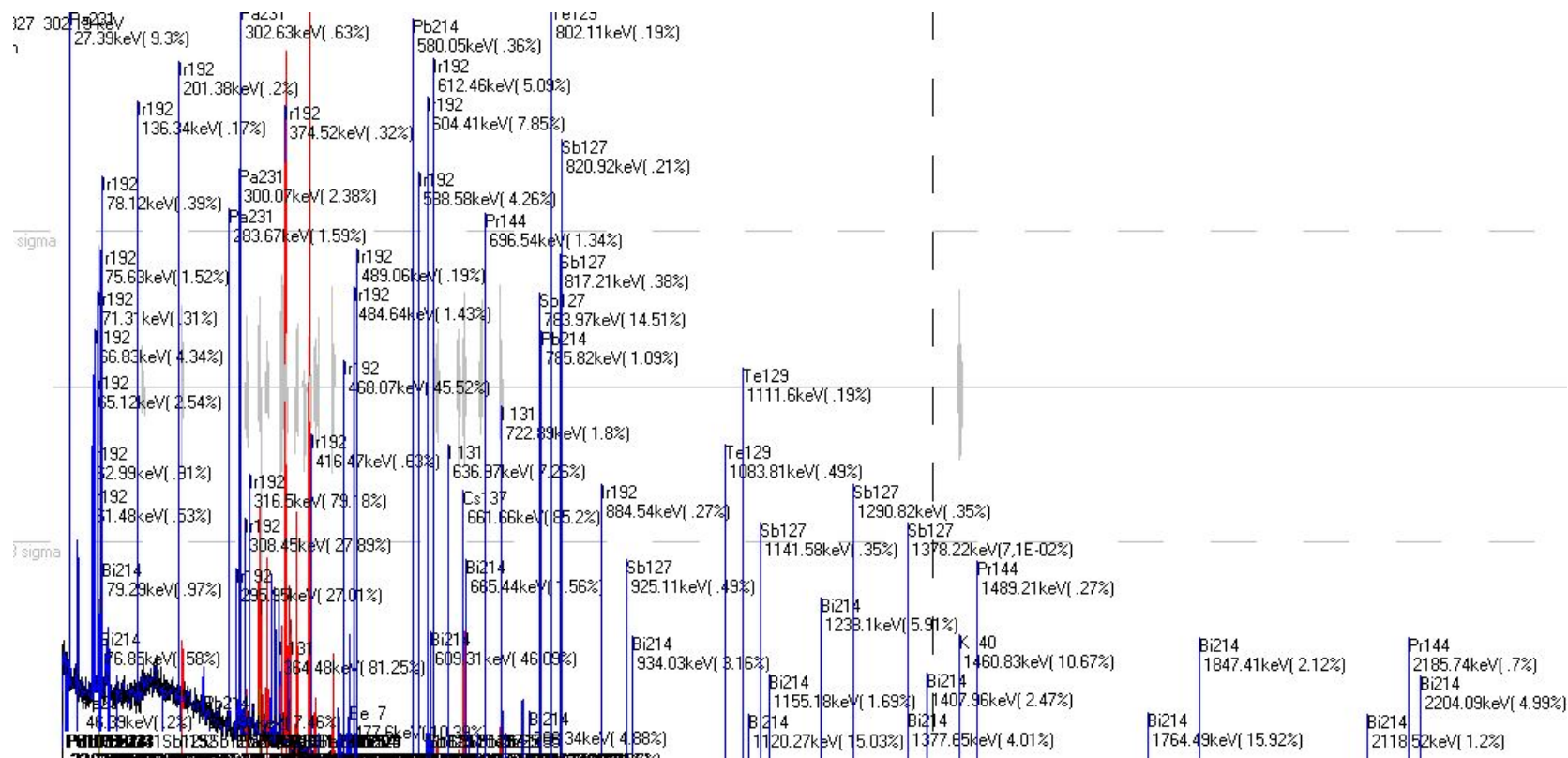
Select peaks based on
relative emission
probabilities!

Smart library creation saves time and reduces errors in the identification process.

A library with too many lines can be as useless as one with too few!

Smart library creation saves time in the identification process.

A library with too many lines can be as useless as one with too few!



A few questions one should ask when working with libs:

Which **group of isotopes** might I encounter? (nuclear, industrial, natural,.. + age of sample - half-life)

What **detector** do I measure with? (high or low resolution, reflectors,..)

Does the isotope itself give a respective line or a **daughter nuclide**? (eg. Cs-137 and Ba-137m)

What ID-program do I use? (lib file according to software specification)

Is the nuclear data I rely on accurate? (in NUCLEONICA eg. JEFF-file)

Have fun creating your own



Gamma Library



... web driven nuclear science

Thank you for your attention!